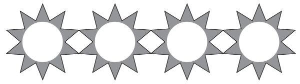
The Energy Sourcebook—High School Unit

TVA Environmental Research Center
P.O. Box 1010, CTR 2C
Muscle Shoals, AL 35662-1010
205-386-2714
205-386-2126 (fax)



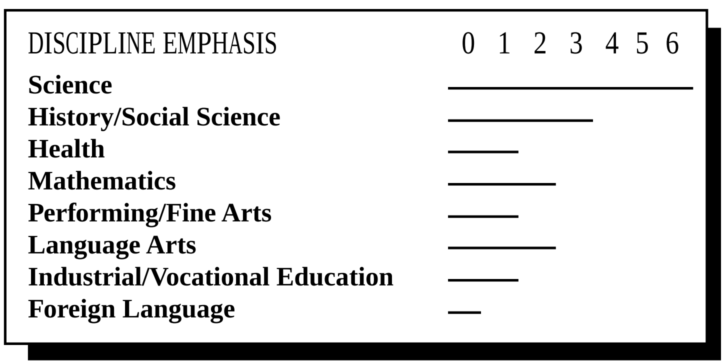
$35 each; 1990.

Grades 10-12

The “Sourcebook” is intended to aid teachers in teaching not only basic science concepts, but real-life application of these concepts in energy studies.

REPORT CARD

Overall Grade	**A-**
General Content	**A-**
Presentation	**B+**
Pedagogy	**A-**
Teacher Usability	**A-**
Energy Content	**A-**



COMMENTS

General Content
There is good integration of earth, life and physical science. Interdisciplinary in scope.

Presentation
Black line masters for transparencies and student activities are good. Needs to update some energy graphs (some date to 1977).

Pedagogy
Good hands-on activities and simulations.

Teacher Usability
Some of the chemicals used in these activities are not allowed in California schools (i.e. Carnog’s fixative with chloroform). Includes a complete reference list for each section.

Energy Content
Explains basic energy concepts with simple demonstrations.

Additional Evaluator Thoughts
Highly recommended for environmental education or energy component of any science curriculum.

ALCOHOL AS AN ALTERNATIVE FUEL

OBJECTIVES

The student will do the following:

1. Produce alcohol by the fermentation of a plant product.

2. Compare the burning characteristics of alcohol to those of kerosene or other petroleum products.

SUBJECTS:
Chemistry, General Science

TIME:
3 class periods

MATERIALS:
bottles or other narrow-necked containers, molasses, yeast, cotton plugs (for bottles), cardboard box, lamp with 40-watt bulb, distillation apparatus, evaporating dish, matches, kerosene, student sheet (included)

BACKGROUND INFORMATION

Alcohols are a group of compounds that consist of carbon, hydrogen, and oxygen. They can be used as clean, renewable fuels for cars and homes. Two members of this group are methanol or wood alcohol (CH_3OH) and ethanol or grain alcohol(CH_3CH_2OH). Methanol is poisonous if taken internally but is widely used as "dri-gas" and windshield cleaner. Ethanol is found in alcoholic beverages and is used in some medicines. 2-Propanol or isopropyl alcohol ($CH_3CHOHCH_3$) is used as rubbing alcohol.

Alcohols have long been used as fuels for fondue pots, in campstoves, and in survival kits because they burn cleanly and are portable. Some alcohols are used as fuel for auto racing because they give superior performances in some racing engines (compared with using gasoline). Alcohol mixed with gasoline in a proportion of 10 percent ethanol to 90 percent gasoline can be burned in most automobiles without modification. This blend is called gasohol. (The use of gasohol might damage fuel line seals in some automobiles; before using blended fuels, check the owner's manual.)

There are several reasons for considering the use of alcohols as fuels. Plant materials (a kind of biomass) can be used to produce these alcohols, especially ethanol. Biomass is a renewable resource, whereas our rapidly vanishing petroleum resources are nonrenewable. Biomass resources suitable for alcohol production are readily available in the United States, including the Tennessee Valley, and could help reduce our dependency on imported fuels. The technology for alcohol production from grains is well known and can be implemented easily.

Ethanol is produced from materials whose carbohydrate content can be fermented. Various grains, sugar-producing crops, and potatoes and other starchy plants are commonly used to make ethanol. Fermentation of these materials yields a very weak alcohol solution that must be distilled to a usable concentration; adequate concentration is usually above 95 percent ethanol. Grain contains both proteins and carbohydrates. One bushel of corn (56 pounds) will produce 2.6 gallons of 100 percent (anhydrous) ethanol, as well as 17 pounds of distilled dried grain (protein) which can be fed to livestock. Sugary substances, such as molasses, contain only carbohydrates, and are easily converted by fermentation into ethanol.

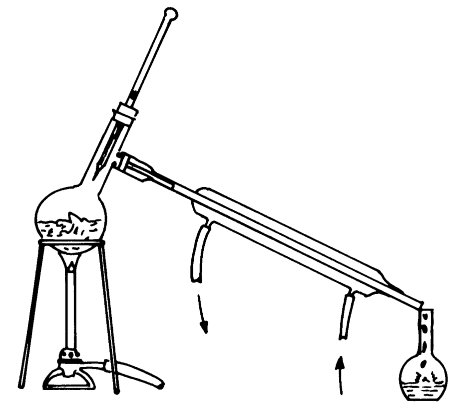
PROCEDURE

I. Share the "Background Information" with the students. Tell them they will be fermenting sugar to produce alcohol.

II. Give each student a copy of the student sheet (included). Divide them into groups of three students each. Distribute the bottles, cotton plugs, molasses, and yeast to the groups. Make the cardboard box and the lamp available.

III. Have the students prepare their fermentation mixtures according to the directions on the student sheet, placing their bottles in the box for overnight fermentation.

IV. The next day, assemble the distillation apparatus (as shown in the diagram) and distill the alcohol from the combined mixtures.



A. Have the students measure and record the temperature within the flask on the chart on the student sheet.

B. Distill 20-30 ml of clear liquid; then remove the heat and stop distilling.

V. Compare the burning of the distillate and a petroleum product.

A. Place the distillate in an evaporating dish and try to ignite it. If it burns, have the students write a few sentences about the color of the flame, any odor, and whatever residue or ash that remains.

B. Ignite a small sample of kerosene or other petroleum product in the same manner as the distillate. Have the students write down their observations about the burning kerosene. Ask them which might make the best fuel—the distillate or the kerosene? Why?

C. Demonstrate the miscibility of alcohol and water. Ask the students how the miscibility of alcohol and water might pose problems in using alcohol as a fuel.

VI. Continue with the follow-up below.

Renewables Are Ready: A Guide to Teaching Renewable Energy in Jr and Sr High School Classrooms

Union of Concerned Scientists
Publications Unit
Two Brattle Square
P.O. Box 9105
Cambridge, MA 02238-9105
617-547-5552
617-864-9405 (fax)
http://www.ucsusa.org

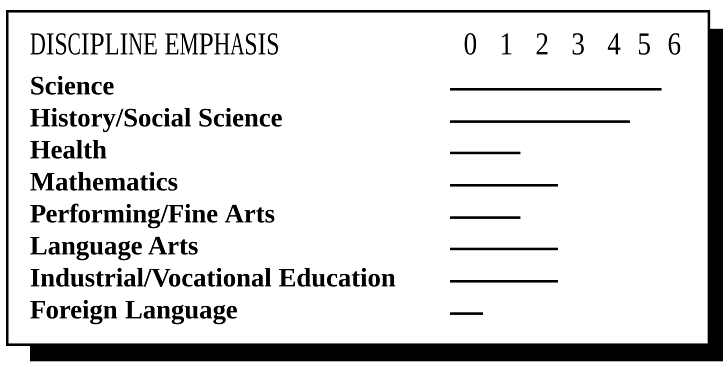
$5 for single copies, $3 each for orders of 10 or more. Add 20% for shipping and handling. 101 pages, 1994.

Grades 7-12. Evaluation based on review of materials for grades 10-12.

This guide is intended to help teachers introduce students to renewable energy technologies and to the political and economic conditions necessary for their implementation.

REPORT CARD

Overall Grade	**A-**
General Content	**B+**
Presentation	**B+**
Pedagogy	**A-**
Teacher Usability	**A**
Energy Content	**A-**



COMMENTS

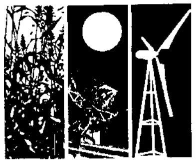
General Content
Good selection of activities to support the teaching of renewable energy sources.

Presentation
There are some great ideas here.

Pedagogy
Contains several student-centered activities using a constructivist approach to enhance student understanding. Very hands on, minds on.

Teacher Usability
Safety needs to be beefed up — “Be careful not to burn yourself (on the Bunsen burner)” is inadequate. Annotated resource guide included.

Energy Content
Information on the sources of renewable resources are thorough.



Biomass

Biomass is organic material--material from plants or animals--that can be burned to produce heat or can be converted into liquid or gaseous fuels. This experiment shows students how to produce a burnable gas by destructive distillation, or pyrolysis, of biomass.

Biomass combustion does produce carbon dioxide, a greenhouse gas. However, if all land used to grow biomass is replanted, there is no net addition of carbon dioxide to the atmosphere.

Before 1900, biomass--in the form of wood--was the United States' main energy source, but today it provides only 4-5% of the nation's primary energy needs. It could supply more. Using waste for biomass is especially promising. Crop and animal wastes or organic municipal wastes can be burned or converted into fuels instead of being dumped in landfills. Methane is collected from some landfills and burned for energy, and ethanol from grain surpluses is converted into a gasoline additive in some parts of the country. There is also considerable potential for growing biomass energy crops for thermal energy or fuel.

Converting biomass to liquid or gaseous "biofuels" is convenient for fueling vehicles. Gasification, pyrolysis, and fermentation are some of the processes that can turn biomass into fuels such as syngas, methanol, or ethanol.

GRADES: 10-12

TIME: one class period (45 minutes)

SUBJECT: science (chemistry)

MATERIALS: Divide the class into groups of 2-4. Each group needs:

- biomass source--small wood chips are suggested (you could use cut-up splints)
- large test tube and test tube holder
- Bunsen burner
- rubber stopper with one hole
- glass tubing that fits snugly in stopper hole
- wood splint
- mass balance
- safety glasses

CAUTIONARY NOTE: The gas produced in this experiment can be explosive under pressure. Close supervision is recommended. Students should wear safety glasses. Be careful that students are not burned by the burner or splint flame. Provide adequate ventilation; make sure the test tubes are vented as illustrated in the diagram.

PROCEDURE:

1. Ask students if they know what biomass is. See if they can name some kinds of biomass. Ask them to think of ways biomass can supply human energy needs.
2. Describe to them different kinds of biomass. Show how they are used as energy sources in the world today. Describe what biofuels are and how they are created and used.
3. Perform the experiment. Explain the directions carefully beforehand; distribute the directions as a handout. Supervise the students closely; for safety reasons, you may want to divide the class into groups of a size that is most easily managed.

FOLLOW-UP:

1. Ask students to draw conclusions from their measurements. How much mass was lost from the wood in the test tube? Where did this extra mass go? What was the mass of the gas?

   Note: The lost mass will not tell you precisely how much gas was produced, because not all gases will burn.
2. Would this be an efficient way of producing biofuels? Discuss why or why not. You may want to discuss the advantages and disadvantages of using energy to convert biomass to biofuels.
3. Assign independent research projects on biomass. Possible topics are:

   - biomass from crop and animal waste or from human trash
   - different kinds of biomass and how they are used as energy sources
   - biofuels that are used today, such as ethanol, methanol, or syngas
   - techniques of biofuel conversion
   - potential future biofuels or sources of biomass
   - advantages and disadvantages of biomass use
   - biomass and land-use issues

This activity was adapted from *Science Projects in Renewable Energy and Energy Efficiency*, compiled by the National Renewable Energy Laboratory, Boulder, Colorado, 1991.

Living Lightly on the Planet Volume II

Schlitz Audubon Center
1111 East Brown Deer Road
Milwaukee, WI 53217
414-352-2880
414-352-6091 (fax)

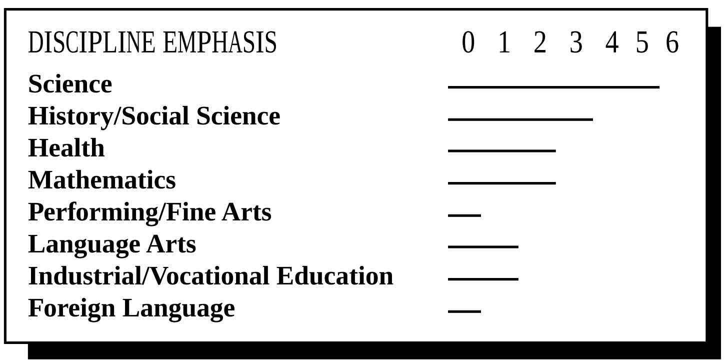
$25 per volume (plus shipping and handling); 205 pages, 1987.

Grades 10-12

This curriculum provides students the opportunity to encounter a variety of viewpoints, examine and clarify their own values, and evaluate some possible alternatives for solving environmental problems.

REPORT CARD

Overall Grade	**A-**
General Content	**B+**
Presentation	**B+**
Pedagogy	**B+**
Teacher Usability	**B_**
Energy Content	**A-**



COMMENTS

General Content
Great for grades 10-12—expectations are appropriate for the level. Provides broad coverage of human impacts on the environment.

Presentation
Concepts presented in lab activities are well thought out. Good case studies. Gray background on text makes reading difficult.

Pedagogy
Numerous student activities involve collaborative learning, role playing, and critical thinking. Assessment tools are only implied.

Teacher Usability
Good topic index at the end. Inconsistent level of background/support materials.

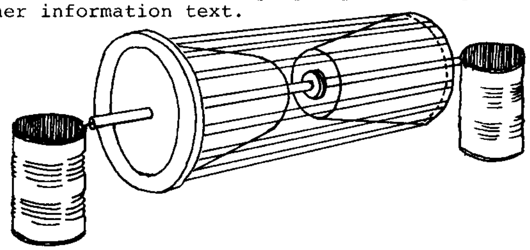
Energy Content
A good presentation and comparison of new energy technologies.

DESIGNING WITH THE SUN **Student Information Sheet**

SOLAR ENGINE

By Edward D. Ray, Inventor

Materials needed: single-edge razor, sharp pencil, flat file, compass, scissors, ruler, two soup cans, two 14 oz. white foam cups, one medium- or large-size white plastic foam plate (such as fresh meat is packaged in), 1/4 inch diameter, 12 inches-long wood dowel, two straight pins, four paper clips, one sheet medium sandpaper, 1/4 inch drill bit, epoxy glue, contact cement, a six- or seven-inch diameter plastic lid, and black polyethylene strips as described in teacher information text.



Directions:

1. With the compass draw two circles on the plastic foam plate with a diameter equal to the inside diameter of the tops of the plastic foam cups. Draw four more circles one inch in diameter. Cut out all the circular disks using the single-edge razor blade. Using the sharp pencil with a twisting motion from both disk sides, punch holes in the centers of all disks so that each fits snugly over the dowel. The dowel should have its ends slightly rounded with the sandpaper.

2. Sand down the edges of the large disks on a slant, so that each disk fits snugly recessed 1/4 inch below each cup end. This will make both cups rigid. Using the 1/4 inch drill bit, carefully drill by hand a 1/4 inch diameter hole in the center of the bottom of each cup.

3. Find the centers of the ends of the dowel and insert the straight pins 1/4 inch into the centers. Take care that the pins provide a centered spin-axis.

4. Mark the center of the dowel length. Assemble the rotor as shown in the drawing. Ensure a good quick-set epoxy bonding of all parts, but do not bond one of the large disks to the dowel.

5. Coat 1/4 inch inner lip of each cup with quick-set epoxy. This provides a surface for gluing the Solar Muscle strips to the cup lips with contact cement. Otherwise, the contact cement will dissolve the plastic foam.

6. After the epoxy has thoroughly set, cut a half-inch radius center hole in the large disk that was not glued to the dowel. Remove the cutout disk from the dowel. This allows one of the cups to wobble about the dowel axis.

7. Now take a SM strip you stretched previously, hold it against both cup ends, and cut it to length so that 1/4 inch extends beyond each cup end. Cut 24 strips this way. Apply contact cement to the epoxy surface on the inner lip of each cup and to the 1/4 inch ends of the SM strips. Keep each ring of contact cement well inside the epoxy-coated surface to avoid dissolving the foam.

8. Attach the SM strips symmetrically around the cups, parallel to the dowel, with each end of each strip cemented to the cups' inner lips. No two strips should touch along the rotor, and spacing between the strips should not exceed the strips' width. The design is forgiving in that only a few strips will drive the rotor, but the object is to attach as many strips as possible, symmetrically, while allowing some cooling space between the strips. In attaching the SM strips, take up all the slack in them, but apply only slight tension to flatten the strips. The "smart" plastic knows the right amount of tension, and this tension will automatically be taken up when the rotor turns in the sun.

9. File a notch in the rim of each soup can in which the pins can turn freely. Weight the cans with sand or dirt so they won't easily tip.

10. Place the rotor on its soup-can friction bearings in a sunny window and, by hand, rotate the motor slowly until the SM tightens to assume its natural tension. About five minutes of slow turning in bright sun will complete the process. Remove the rotor from sunlight.

11. Cut a two-inch-diameter hole at the center of the plastic lid. Apply a cup-size ring of contact cement to the underside of the plastic lid in a half-inch ring for later attachment to the "wobbly" cup top. Apply contact cement very lightly around the rim of the wobbly cup.

12. Attach the plastic-lid flywheel (not shown in illustration) to the wobbly cup rim, being careful to center it on the axle (more important than centering on the cup). Balance the rotor by attaching paper clips to the rim of the flywheel.

13. Place the solar motor in a sunny window, and it will turn at about 50 rpm. It turns fastest with the sun directly above, but if well balanced, it will run slowly till late in the day. You'll note that the motor will self-start and run in both directions, but it prefers to turn top over to the sun. As you've probably guessed, the motor turns by the SM contracting on the hot side and relaxing on the shaded side, thereby constantly lifting the flywheel above the rotor's center of gravity and allowing it to continuously "fall around."

Issues, Evidence and You

Sargent-Welch
P.O. Box 5229
Buffalo Grove, IL 60089-5229
1-800-727-4368
1-800-676-2540 (fax)
http://www.sargentwelch.com

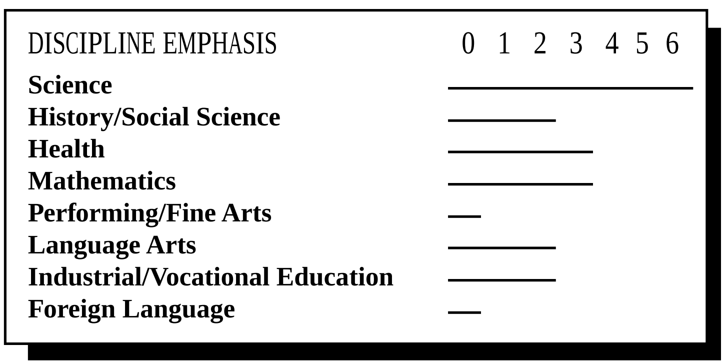
$4,028.99 (full year course which includes materials kit with equipment for 5 classes of 32 students, teacher's manual, and 32 sets of student books - replacement books available); 1995.

Grades 7-12. Evaluation based on review of materials for grades 10-12.

A diverse educational program highlighting science and its uses in the context of societal issues.

REPORT CARD

Overall Grade	**A-**
General Content	**A-**
Presentation	**A-**
Pedagogy	**B+**
Teacher Usability	**A**
Energy Content	**A-**



COMMENTS

General Content
Raises real-world questions for which there may be multiple solutions. Activities are thematically tied together.

Presentation
The criteria for instructional materials is excellent.

Pedagogy
Fun, hands-on activities.

Teacher Usability
Student activity books and materials must be ordered from specific providers. Does not consider time limitations of typical high school periods.

Energy Content
Set of 12 units addressing various aspects of energy uses, sources, and quantification of energy transfer/loss process.

Additional Teacher Thoughts
This appears easy to use and teaches great science while having kids work on scenarios and apply their learning.

Activity 57 Controlling Radiant Energy Transfer

A "Reflective" Question

In the last activity, you did investigations to find out how to capture and store energy from the sun. In this activity, you will look at methods for preventing unwanted heating by the sun.

Challenge

Learn how the transfer of energy from the sun can be controlled by special materials.

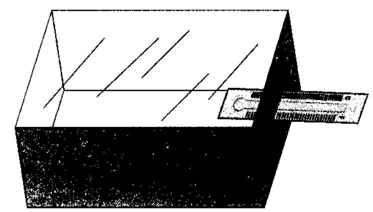
Materials

For each group of four:

- Two metal-backed thermometers
- One piece of clear plastic film
- One piece of reflective plastic film
- Two prefolded boxes
- Masking tape (approximately 30 cm or 12 inches)

Procedure

Look at your two pieces of plastic film. Plan an investigation that will allow you to compare the ability of these two plastic films to prevent the transfer of the sun's heat through a window into a room. Use the box and thermometer as shown below to simulate a room with a window. Carry out your investigation.



1. Write a summary describing the results of your investigation.
2. Think about the investigations you did in the last two activities. There were some similarities and some differences between the investigations. Describe how you used materials to accomplish the different energy transfer goals in Activities 56 and 57.

   Be sure to identify:

   a) the energy chains involved;

   b) the effect of the materials chosen on the energy transfer; and

   c) the results of the decisions made in each case.

Electric Vehicle Classroom Kit

EV Media
612 Colorado Ave., Suite 111
Santa Monica, CA 90401
310-394-3980
310-394-3539 (fax)

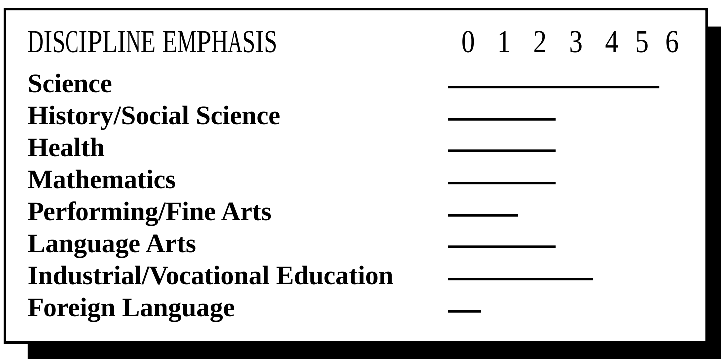
Kits start at $139.50 (includes a 121 page teacher's book, 35 student booklets, and five model car kits); 1996.

Grades 7-12. Evaluation based on review of materials for grades 10-12.

The teacher's book provides information and suggestions for conducting a unit; the unit is built around a sequence of activities, some of which are optional.

REPORT CARD

Overall Grade	**B+**
General Content	**B+**
Presentation	**B+**
Pedagogy	**A-**
Teacher Usability	**B+**
Energy Content	**B+**



COMMENTS

General Content
A well-integrated approach to energy conservation through the application of science and technology. Prepares students for the future.

Presentation
Exceptionally clear and thorough teacher directions. Artistic layout of instructional materials is appealing.

Pedagogy
Assessments are excellent. Good group projects.

Teacher Usability
Narrow focus on energy and transportation limits the scope of how and where a teacher would use the unit. Suggestions for materials in kit are given so teachers can purchase the teacher's edition and not the kit and still get the materials for making the cars.

How Can We Measure the Concentration of Air Pollutants?

Overview

This optional lesson demonstrates how the concentration of an air pollutant can be measured.

Processes

Observe.
Communicate.
Compare.

Objectives

Experience

✓ detecting a substance through a chemical change.

Know

✓ Substances present in very small amounts can have detectable effects.

Are Able to Do

✓ relate descriptions of concentration to quantities in a given volume (or mass, depending on how the concentration was expressed).

Assessment

Evaluate the worksheets for completeness.

Heterogeneous grouping

Besides reagents and some equipment, this activity requires some careful reasoning by students.

A little background

Does the air we breathe really contain "chemicals" other than the gases with which students are familiar? An investigation can show that it does (if indeed it does), and if you wish, the results can be roughly quantitative.

One way of testing for the presence of sulfur dioxide in the air is to bubble it through a solution of potassium permanganate in water; the purple solution will become almost colorless (the manganese sulfate is slightly pink). The reaction is:

$$2KMnO_4 + 5SO_2 + 2H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 2H_2SO_4$$

By finding the masses of the 2 potassium permanganate molecules and the 5 sulfur dioxide molecules, we can use this reaction to determine the mass of sulfur dioxide in a quantity of air.

Potassium	39.10	times 1 =	39.10
Manganese	54.94	times 1 =	59.94
Oxygen	16.00	times 4 =	64.00

for a total of 158.04 atomic mass units for one molecule, or 316.08 atomic mass units for 2 molecules. For the sulfur dioxide,

Sulfur	32.06	times 1 =	32.06
Oxygen	16.00	times 2 =	32.00

for a total of 64.06 atomic mass units for one molecule, or 320.30 for 5 molecules.

So the ratio of the mass of potassium permanganate to the mass of sulfur dioxide needed to decolorize it is 316.08:320.30, which is 0.99:1. So 1 gram of sulfur dioxide decolorizes 0.99 gram of potassium permanganate.

This reaction requires an acidic environment, which we can ensure by adding a few drops of hydrochloric acid.

Materials needed

- ❑ potassium permanganate
- ❑ dilute hydrochloric acid
- ❑ aquarium air pump
- ❑ 250-mL Erlenmeyer flask or similar bottle
- ❑ 2-hole rubber stopper to fit above flask
- ❑ glass tubing to fit above stopper; one piece about 7.5 cm long, the other long enough to reach almost to the bottom of the flask. If you have to cut the tubing, fire polish the ends.

- ❑ rubber or plastic tubing. It often happens that the diameter of the output tube on the air pump is not the same as the diameter of the glass tubing in the rubber stopper. Rubber tubing can sometimes stretch to accommodate both, but vinyl and Tygon won't, in which case you may need to make a small adapter from a short length of the glass tubing. Heat the tubing over a flame and pull it out to reduce the diameter to equal that on the air pump. (It is easy to get it too small!) After it cools, score the middle of the waist and break it off.
- ❑ stirring rod
- ❑ balance, weighing paper or pan
- ❑ 125-mL or so bottle to store stock solution
- ❑ 100-mL graduated cylinder
- ❑ two 1-mL pipettes

Preparing the stock solution

Weigh out 0.99 gram of potassium permanganate. Add to 50 mL of distilled water and stir until dissolved. Pour the 50 mL of solution into a 100 mL graduated cylinder or volumetric flask and add distilled water to bring to 100 mL. Store this solution in a tightly stoppered, labeled bottle of about 100 mL capacity. Don't make this stock solution in large quantities, because it deteriorates on exposure to the air.

Preparing the flask for the investigation

Because inserting glass tubing through stoppers is a potentially hazardous procedure for inexperienced students, we suggest you prepare the flask in advance.

Pour 100 mL of distilled water into the flask. With a pipette, add 1 mL of the 0.99% potassium permanganate solution. With another pipette, add 1 mL of dilute hydrochloric acid.

Insert a stopper with two glass tubes, one short and the other reaching almost to the bottom of the flask, well below the surface of the solution. Plastic tubing from the air pump is to be attached to this second tube.

Interferences

Certain other substances can decolorize the solution, in particular sulfates (adsorbed on particulates). But the test is still a good way of demonstrating the principles behind measuring concentrations of air pollutants.

Energy, Economics and the Environment

Indiana Department of Education
Office of Program Development
Attn: Rose Sloan
Room 229, State House
Indianapolis, IN 46204-2798
317-232-9186
317-232-9121 (fax)

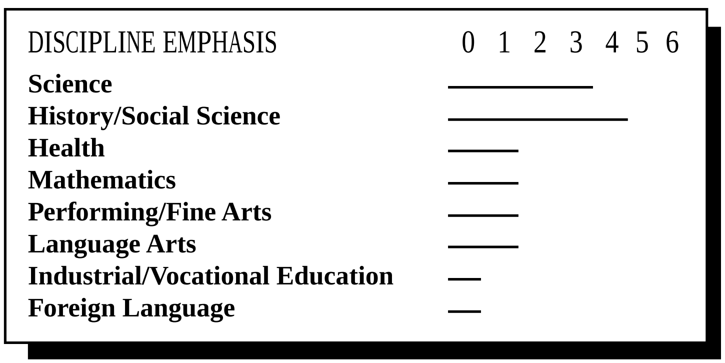
$8 per copy; 155 pages.

Grades 10-12

This curriculum provides a conceptual framework for analyzing energy and environmental issues, and provides teachers with a set of motivational, interdisciplinary teaching units centering on these important issues.

REPORT CARD

Overall Grade	**B**
General Content	**B+**
Presentation	**B**
Pedagogy	**B**
Teacher Usability	**B-**
Energy Content	**B+**



COMMENTS

General Content
Strong bias to consumption and profit.

Presentation
Scenarios are good. Good evaluation model provided to deal with difficult questions.

Pedagogy
Some activities are open ended and collaborative.

Teacher Usability
Requires more of an economics background than most science teachers may have.

Energy Content
Specific to renewable energy resources.

Activity 8

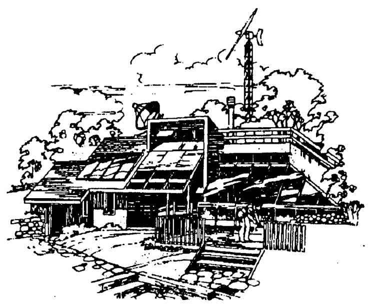
Case Study

The Case of the Energy Subsidy

Student Directions:

1. The Senate is considering energy policies to give tax breaks to renewable energy sources and to increase taxes on fossil fuels. You will be asked to take part in public hearings involving these issues.
2. After you research the various energy sources, you will be assigned a role as either a senator or one of the lobbyists representing various special interests and geographic regions.
3. Fill out a Decision Worksheet and Decision-Making Grid to help you come to a decision. Much depends on you. Good luck.

SCENARIO



The year is 1998. United States dependence on foreign petroleum, which became a problem in the early 1970s, continues to grow. In addition, concern rises over the environmental costs associated with the use of fossil fuels. Renewable energy sources are an option in some regions, but they have been slow to develop commercially. Connecticut, for example, has access to hydroelectric power, but usage has actually declined during the past century, because of relatively cheap fossil fuels. To help change this trend, Connecticut Senator Jonathan Barnhart has sponsored a bill to provide special tax breaks, or subsidies, for developers of renewable energy sources, including solar, wind, geothermal, hydropower, and biomass. These tax subsidies would take the form of tax credits, or rebates, for qualifying energy projects.

Senator Barnhart's proposal received mixed reviews in the Senate. Senators from the five top oil producing states – Texas, Alaska, Louisiana, California. and Oklahoma – expressed concern that the bill would put oil producers at a disadvantage that could result in serious job losses in their states. Three of those states, Texas, Louisiana, and Oklahoma, are also the top producers of natural gas, leading their senators to argue even more strongly against a subsidy for competing renewable fuels. Noting that renewable fuels are not yet competitive in price without tax subsidies, they argue that consumers would get the best product at the lowest price by letting the market determine what type of energy to produce and in what quantities. In addition,

they object to any programs that would increase the size of the federal budget deficit at a time when program cuts and tax hikes are being proposed to deal with the out-of-control federal budget.

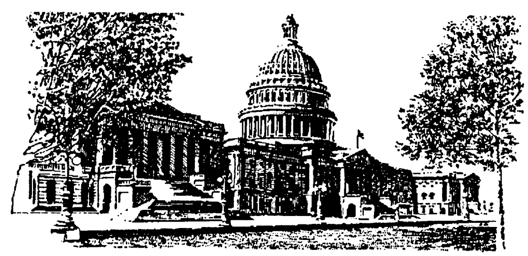
Environmental groups and developers of renewable energy sources disagree. They claim that fossil fuels already receive a subsidy from the general public in the form of environmental damage that does not get charged back to those who are responsible. They assert that fossil fuels would cost a lot more if the environmental costs to society were included. According to the environmentalists, we tend to be short-sighted in dealing with nonrenewable resources by not taking into account their finite nature until it is too late.

Oil company representatives respond that it was the free market that developed petroleum back in the mid-nineteenth century when whales became relatively scarce and there was concern that they might be driven to extinction. Oklahoma Senator Susan Phillips reminds Senator Barnhart that we avoided a whale oil crisis a century ago not through special subsidies, but through the free market responding to a shortage of whale oil by raising its price. Says Senator Phillips, "The higher price of whale oil actually created a market for petroleum and other energy sources by encouraging both consumers and producers to look for cheaper alternatives."

The president of the Sierra Club, Belinda Arbuckle disagreed. "For free markets to operate effectively, people need to pay the full cost of their actions. Our failure to take into account the full long-run costs of fossil fuels to society makes it difficult for producers of renewable energy sources to compete. I proposed new taxes on fossil fuels reflecting the environmental damage associated with their production and use. This would tend to increase the cost of fossil fuels reflecting their environmental impact and making it easier for renewable energy sources to compete on the basis of price."

The fossil fuel industry response is that we do not need another tax on energy to clean up the environment, especially in light of the mixed scientific evidence on the damaging effects of sulfur dioxide and other pollutants from fossil fuels. The industry also reminds the Senators that an energy tax would have negative effects on jobs and growth throughout an economy dependent on fossil fuels.

The Senate is undecided about what to do, and is calling for special hearings. Should the Senate, 1) support the Barnhart proposal to grant subsidies to producers of renewable energy, 2) support the Sierra Club proposal to tax fossil fuels, or 3) do neither and let free markets determine energy use?



Energizing Your Future with Energy, Economics and the Environment.

National 4-H Council
National 4-H Supply Service
c/o Cresstar Bank
P.O. Box 79126
Baltimore, MD 21279-0126
301-961-2934
301-961-2937 (fax)

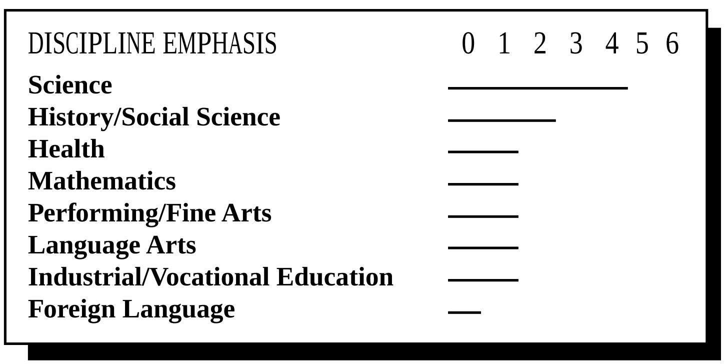
Item #ES1009: $5 per copy, 1996.

Grades K-12. Evaluation based on review of materials for grades 10-12.

This guide contains five chapters, each focusing on a different topic related to the interrelationships between energy, economics, and the environment.

REPORT CARD

Overall Grade	**B**
General Content	**B**
Presentation	**B+**
Pedagogy	**B**
Teacher Usability	**B**
Energy Content	**B+**



COMMENTS

General Content
Sound activities that encourage students to explore environmental topics. Activities may not be challenging to upper high school students.

Presentation
Good, simple, clear activities.

Pedagogy
Wide variety of activities involving games, contests, role playing, and group discussion.

Teacher Usability
Good resource references. More appropriate for mixed age, informal education groups.

Activity 5.2
A Matter of Invention

Activity Goals
To discuss global options for alternative sources of energy.

Preview
Participants discuss options for alternative sources of energy and design inventions using these sources.

How to Do the Activity
Ask participants to name their favorite inventions from the last 200 years. Write their responses on a chalkboard or flip chart. Here are some to get you started:

television
washing machine
computer
CD player
automobile
skateboard
bicycle

Ages: 9 to 18
Style: adult
Life Skills: speaking before a group, understanding and using new technologies, identifying problems, planning for the future, leading change
Pre-Activities: 2.1, 2.2, 2.3, 3.4, 5.1
Time Needed: 30 minutes
Group Size: any
Indoors or Outdoors: either
Materials Needed: copies of Activity Sheets 5.2A and 5.2B cut into cards, art paper, pencils, crayons, markers, toothpicks, modeling clay, papier mache', glue, craft sticks, other art materials (see Activity)

Ask them to name the energy sources used to run these inventions. On the chalkboard or flip chart, draw an arrow from the invention to the energy source. If it's electricity, write down the primary source of electricity in your area, e.g.:

television __________ electricity________coal

Do this for several examples. Point out to participants that historically, as new sources of energy have been discovered, inventions were created to use them. For example, when electricity became widely available, the toaster, television, and stereo became possible.

Ask participants what things might be invented if alternative energy sources were more developed. What would our lives be like if we used alternative energy sources to run our favorite inventions?

Divide the group into teams of three or four. Hand out one prepared card from each activity sheet to each team. Give them the following assignment: Design an invention that can be used in the assigned country using the fuel named. It should replace one of the items from the favorite invention list participants generated earlier. For example, a team may draw a biomass card and Papua New Guinea card. A favorite invention might be a television. Therefore, team members would have to design a television that runs on wood or crops that can be used in Papua New Guinea. They would have to speculate whether the fuel is abundant, giving the description of the country. They also

should consider whether the invention is energy efficient.

Give the teams art supplies. Have them sketch or build a model of their design. They can make the artwork as elaborate or simple as they wish.

When teams are done, let each share its invention with the group. Do any participants have ideas for improving the invention? Would the invention be widely used in the country it is built for? How difficult would it be to harness the alternative energy source for the invention?

Evaluating Progress
Name some alternative energy sources being used today. What effect would your invention have on people if it were used?

Fair Game
Use your invention as an exhibit! Include information on the energy source, such as availability and how it is generated.

One for All and All for One
Think globally! Energy use is different in every country. Tiny Nepal holds eight of the 10 tallest mountain peaks in the world. Water comes rushing down these mountains, providing the source of most of the electricity in the country. But people who live in Nepal also rely heavily on wood and agricultural residues for heating and cooking. Energy ideas that may be accepted in another country, such as using a windmill to pump water from underground, may not be practical for Nepal.

As a group, become more familiar with our global neighbors. Pick a country to research. You can have a special celebration and serve traditional foods cooked using traditional methods.

Energy Use

Global Systems Science
Lawrence Hall of Science
University of California
Berkeley, CA 94720-5200
510-642-0552
510-642-1055 (fax)
email: csneider@uclink4.berkeley.edu

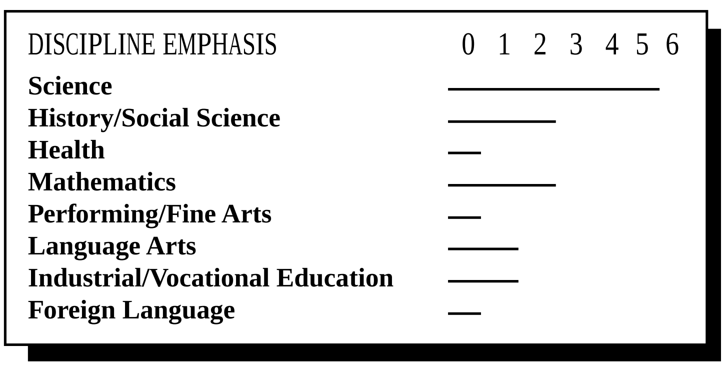
Call or write for price information and availability of trial edition (under development).
30 page teacher's guide, 102 page student guide; 1995.

Grades 10-12

An interdisciplinary course for high school students that emphasizes how scientists from a wide variety of fields work together to understand significant problems of global impact.

REPORT CARD

Overall Grade	**B**
General Content	**B+**
Presentation	**B-**
Pedagogy	**C+**
Teacher Usability	**C+**
Energy Content	**B+**



COMMENTS

General Content
Content is thematically organized and holds great potential for in depth student learning.

Presentation
Great for students who like to read. Easy to overlook some activities.

Pedagogy
Only three student activities per unit; seems book centered.

Teacher Usability
Good for a reference.

Energy Content
Most of the material focuses on electrical energy.

Chapter 5

The Electric Power Grid

As electric companies grew, power plants were linked together in networks which covered different regions of the country. But by the start of the 1960's there was not yet a single unified network. Different networks even provided different frequencies of alternating current, ranging from 25 to 60 cycles per second. Continued growth and development required a standard for the country. The Federal Energy Regulatory Commission (FERC) and state utility commissions were organized, and today they coordinate the growth of huge power networks, containing hundreds of power plants, called the *electric power grid*. The power grid links users and producers of electrical power in the United States and parts of Canada.

In order for different generators to feed power into the grid they must be working at the same speed to produce the same frequency of AC. Each generator must be pushing the current forward at the same time, and each must reverse the current at the same time. If one generator is shut down for a while, it must be brought up to speed before it is connected to the others so that all the generators operate in synchrony with each other. Each generator operates in lock-step with every other generator; and all of these power plants are connected to streetlights, electric trains, factories, homes, and business.

Sectional Maps of the North American Power grid

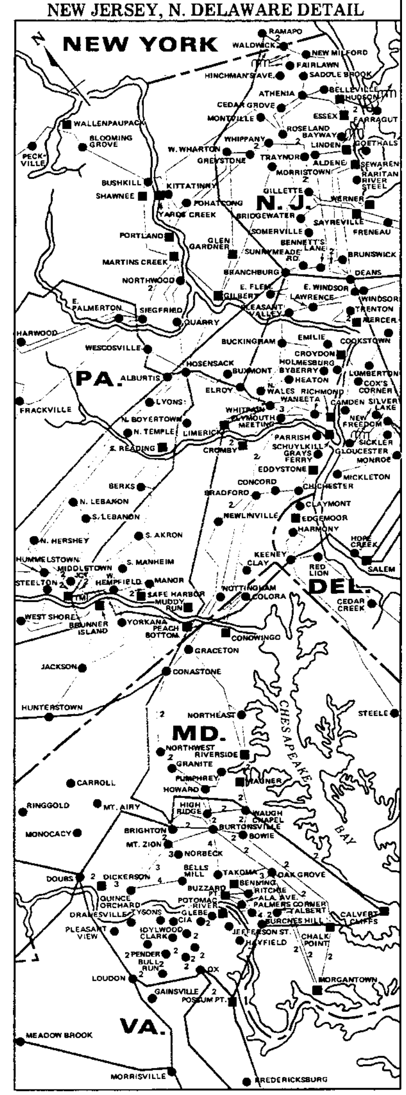
Courtesy of North American Electric Reliance Council, 1994

Transmission Lines

Numbered Lines depict Multiple Circuits.

	Existing Lines	Future Lines
Direct Current	▬▬▬	‑ ‑ ‑ ‑
735/765 kV.	———	- - - -
500 kV.	———	- - - -
345 kV.	———	- - - -
230 kV.		
Below 230 kV.	———	- - - -
Power Station	■	
Substation	●	

E. PENNSYLVANIA, MARYLAND, NEW JERSEY, N. DELAWARE DETAIL



Daily operation of the power grid

Imagine millions of people returning home at the end of a hot work day in summer, turning on lights and air conditioners. As the load on the power grid increases, more energy is required to turn the generators. At first they start to slow down. Voltage goes down. AC frequency goes down.

This would be an emergency if it were allowed to continue. Electrical usage requires about 120 V at nearly exactly 60 cycles per second. Before the frequency drops even to 59 cycles per second the change is detected in the system control room which monitors the operation of the power grid for a power company's service area. Power plants that have been standing ready are brought on line. The power generated matches the load and the frequency goes back to 60 cycles per second.

In the early evening people switch off lights and appliances as everyone goes to bed. As the load goes down, generators are disconnected from the grid. This cycle happens every day.

4-H Home Conservation Guide

California Energy Commission
Education Information
1516 Ninth Street, MS 29
Sacramento, CA 95814
916-654-4989
916-654-4420 (fax)
http://www.energy.ca.gov/education

$1.50 per copy.

Grades 4-12. Evaluation based on materials for grades 10-12.

A collection of hands-on projects accompanied by background information which teach home energy conservation skills.

REPORT CARD

Overall Grade	**B**
General Content	**C+**
Presentation	**B**
Pedagogy	**B**
Teacher Usability	**B+**
Energy Content	**C+**

DISCIPLINE EMPHASIS

DISCIPLINE EMPHASIS	0 1 2 3 4 5 6
Science	
History/Social Science	
Health	
Mathematics	
Performing/Fine Arts	
Language Arts	
Industrial/Vocational Education	
Foreign Language	

COMMENTS

General Content
Straight forward, practical, hands-on solutions to increasing energy efficiency in homes.

Presentation
Practical instructions with useful illustrations.

Pedagogy
Excellent energy resource for student involvement in activities utilizing authentic assessment.

Teacher Usability
Some of the projects are very appropriate for all levels of high school students, especially as community service projects.

Energy Content
Several activities allow the students to apply the principles of energy conservation directly in their homes.

STORM WINDOWS

OBJECTIVE: To build effective yet inexpensive storm windows to weatherize windows in homes or other buildings.

ENERGY CONNECTION: A single pane window has an R valve less than one.(Remember: The higher the R-value, the better a material is at insulating.) A window can lose 230 times more heat from your house than an insulated wall of the same area. A double glazed window or storm window can halve that amount.

AUDIENCE: 4-H members with some carpentry skills can assemble this simple straightforward project with minimal assistance from adults..

TIME: 1-2 days

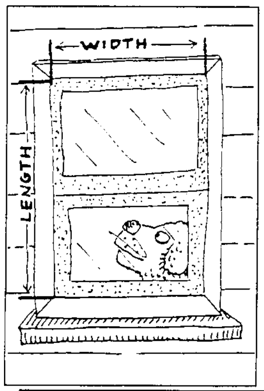
PREPARATION: The directions for members are very detailed and contain a list of tools and materials for the project. Members may need help with measuring to figure out the quantity of materials. If a member doesn't have wood trim on any of their home windows you may want to help them identify a window on another building. This project is relatively inexpensive but will require purchasing materials, some basic tools and an outdoor or shop work environment.

WHAT YOU WILL DO

If several members in your group are interested in this project you may want to assemble a sample storm window as a group at your meeting.

Members could have difficulty with the following steps in this project: measuring lengths and widths, cutting 45 degree angles and assembling frames with corrugated fasteners. You may want to review these steps with interested members.

Corner braces may be used in place of corrugated fasteners and if UV treated polyethylene is not available, regular polyethylene can be used, but it won't last as long.



Storm windows could be constructed for a local community building in need of weatherization. Refer to the community project activity in this packet.

4-H Home Conservation Leader's Guide

MATERIALS GUIDE

WEATHERSTRIPPING DOORS AND WINDOWS
WHAT'S AVAILABLE AND WHAT'S BEST

Here is background information on what the different types of weatherstripping look like, how they work and when is it best to use them. It would be helpful for you to review this information before you start the unit so that you are familiar with weatherstripping materials. You may want to take this packet in a local hardware store to see what types of materials are available in your community.

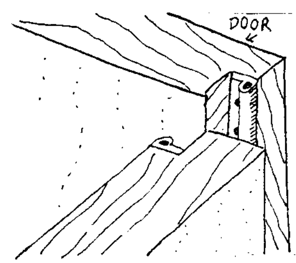
Be aware that there are a wide variety of windows and doors and each requires different types of weatherstripping for the best results. Parents may want a copy of this information if their child is doing a weatherstripping project at home.

We recommend that you encourage members to use this information to try a simple weatherstripping project with their families or do one as a group on a local building.

FACT BOX

If all the small unsealed spaces in a room were combined they could equal a hole the size of a soccer ball. A hole that size would let in quite a breeze.! In older homes 50% of the heat loss can be from infiltration. Weatherstripping can reduce that loss to 10%. Stopping infiltration with weatherstripping should be a first step in weatherizing your home. It is relatively easy and inexpensive.

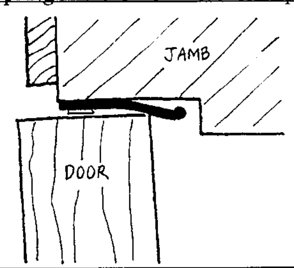
JAMB WEATHERSTRIPPING



Interlocking jamb weatherstripping - (doors) is composed of two parts, one attaches to the door edge and the other to the jamb. They interlock when the door has closed, forming a seal.

Advantage - works well where there are extreme water problems **Disadvantage** - in cold climates can be damaged by ice, rocks can get in channels and damage them

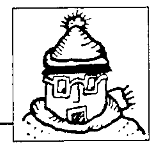
Spring and cushion weatherstripping - are flexible metal or plastic strips which compress to form a seal when a door or window is closed. (used on doors, sliding windows, & sash windows)



Advantages - concealed, excellent seal (looks best, but difficult to install)

Disadvantages - makes doors and windows harder to close, noisier than otherkinds, can wear out because of friction

Rigid gasket weatherstripping - (doors, sash windows) is composed of a gasket



GRADES 10-12